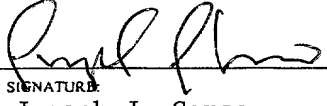


FORM PTO-1390 (REV 12-29-99)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 33585
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371			U.S. APPLICATION NO. (If known, see 37 CFR 1.5) 09/856211
INTERNATIONAL APPLICATION NO. PCT/FR99/02979	INTERNATIONAL FILING DATE 01.12.1999	PRIORITY DATE CLAIMED 02.12.1998	
TITLE OF INVENTION MONOATOMIC AND MONOCRYSTALLINE LAYER OF LARGE SIZE, IN DIAMOND TYPE CARBON, AND METHOD FOR THE MANUFACTURE OF THIS LAYER			
APPLICANT(S) FOR DO/EO/US Vincent Derycke, Gerald Dujardin, Andrew Mayne, Patrick Soukiasian			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<ol style="list-style-type: none"> <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. <input checked="" type="checkbox"/> This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1). <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) <ol style="list-style-type: none"> <input type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau). <input checked="" type="checkbox"/> has been transmitted by the International Bureau. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)). <input type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) <ol style="list-style-type: none"> <input type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau). <input type="checkbox"/> have been transmitted by the International Bureau. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. <input type="checkbox"/> have not been made and will not be made. <input type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)). <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)). 			
Items 11. to 16. below concern document(s) or information included:			
<ol style="list-style-type: none"> <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. <input checked="" type="checkbox"/> A FIRST preliminary amendment. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. <input type="checkbox"/> A substitute specification. <input type="checkbox"/> A change of power of attorney and/or address letter. <input checked="" type="checkbox"/> Other items or information: --Publication No. WO 00/32853; --Copy of Demand for Ch. II; --Int'l. Prel. Exam. Report (French) 			
Express Mail No. <u>EL573567952US</u> I hereby certify that this correspondence is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10, and is addressed to: Assistant Commissioner for Patents, Washington D.C. 20231 on the date indicated below. <u>Debra A. Peterlin</u> Name of Person Mailing Correspondence May 18, 2001 <u>Debra A. Peterlin</u> Date Signature of Person Mailing Correspondence			

US APPLICATION NO. 097/856211 INTERNATIONAL APPLICATION NO. PCT/FR99/02979		ATTORNEY'S DOCKET NUMBER 33585							
17. <input checked="" type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) : Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO \$970.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$840.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$690.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$670.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) \$96.00 ENTER APPROPRIATE BASIC FEE AMOUNT =		<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: left;">CALCULATIONS</th> <th style="text-align: left;">PTO USE ONLY</th> </tr> <tr> <td colspan="2" style="height: 100px; vertical-align: middle; text-align: center;">840.00</td> <td></td> </tr> </table>		CALCULATIONS		PTO USE ONLY	840.00		
CALCULATIONS		PTO USE ONLY							
840.00									
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).		\$ 840.00							
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE						
Total claims	- 20 =		X \$18.00						
Independent claims	- 3 =		X \$78.00						
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$260.00						
TOTAL OF ABOVE CALCULATIONS =		\$							
Reduction of 1/2 for filing by small entity, if applicable. A Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28).		\$							
SUBTOTAL =		\$ 840.00							
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).		\$							
TOTAL NATIONAL FEE =		\$ 840.00							
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property . +		\$ 40.00							
TOTAL FEES ENCLOSED =		\$ 880.00							
		Amount to be:	\$						
		refunded	\$						
		charged	\$						
a. <input checked="" type="checkbox"/> A check in the amount of \$ <u>880.00</u> to cover the above fees is enclosed. b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed. c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>16-0820</u> . A duplicate copy of this sheet is enclosed.									
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.									
SEND ALL CORRESPONDENCE TO: Joseph J. Corso Pearne & Gordon LLP 526 Superior Avenue East Suite 1200 Cleveland, Ohio 44114-1484		 SIGNATURE Joseph J. Corso NAME 25845 REGISTRATION NUMBER							

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant: Vincent Derycke et al.
Title: MONOATOMIC AND MONOCRYSTALLINE LAYER
OF LARGE SIZE, IN DIAMOND TYPE
CARBON, AND METHOD FOR THE
MANUFACTURE OF THIS LAYER
Docket No.: 33585

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to the examination of the above-identified
patent application, it is requested that the following
amendments be made.

IN THE CLAIMS:

Please amend claims 1, 2, 4 - 9 and 11 as follows:

1 1. (Amended) Monoatomic and monocrystalline layer
2 of diamond type carbon, this layer being characterized
3 in that it is formed on the surface of a monocrystalline
4 substrate of SiC and extends closely over the totality of
5 this substrate.

1 2. (Amended) Monoatomic and monocrystalline layer
2 according to claim 1, the SiC monocrystalline substrate
3 being a thin layer of monocrystalline SiC in cubic phase
4 β -SiC formed on a platelet of Si, the monoatomic and

monocrystalline layer thus closely covering the totality of this platelet.

4. (Amended) Monoatomic and monocrystalline layer according to claim 1, covered with a monocrystalline layer of diamond formed by growth from the monoatomic and monocrystalline layer, the latter acting as matrix.

5. (Amended) Manufacturing process of a monoatomic and monocrystalline layer of diamond type carbon, this process being characterized in that one forms a monocrystalline substrate in SiC terminated by a carbon atomic plane according to a c(2x2) reconstruction, this plane being a plane of carbon-carbon dimers of sp configuration , and in that one carries out at least one annealing of this substrate, this annealing being able to transform the plane of carbon-carbon dimers of sp configuration into a plane of carbon-carbon dimers of sp³ configuration thus forming a monoatomic and monocrystalline layer of diamond type carbon.

6. (Amended) Process according to claim 5, in which the SiC monocrystalline substrate is prepared from a thin layer of monocrystalline SiC in cubic phase β -SiC with a face terminated by a layer of Si.

1 7. (Amended) Process according to claim 5, in which
2 the SiC monocrystalline substrate is prepared from a
3 monocrystalline SiC platelet in hexagonal phase with a
4 face terminated by a layer of Si.

1 8. (Amended) Process according to claim 6, in
2 which, to obtain the atomic plane of carbon according to
3 the reconstruction $c(2 \times 2)$, an annealing is carried out
4 capable of eliminating the layer of Si.

1 9. (Amended) Process according to claim 6, in
2 which, to obtain the atomic plane of carbon according to
3 the reconstruction $c(2 \times 2)$, a deposit of hydrocarboned
4 molecules is made on the Si layer followed by cracking of
5 these molecules.

1 11. (Amended) Process according to claim 5, in
2 which, to transform the plane of carbon-carbon dimers of
3 sp configuration into a plane of carbon-carbon dimers of
4 sp³ configuration, one carries out an annealing or a
5 plurality of successive annealings, at a temperature
6 approximately equal to 1250 C, of the monocrystalline
7 substrate in SiC terminated by the atomic plane of carbon
8 according to the reconstruction $c(2 \times 2)$, the total time of
9 annealing being greater than or about equal to 25
10 minutes.

Please add the following claims 12 - 14.

1 12. Process according to claim 7, in which, to
2 obtain to atomic plane of carbon according to the
3 reconstruction $c(2 \times 2)$, an annealing is carried out
4 capable of eliminating the layer of Si.

1 13. Process according to claim 7, in which, to
2 obtain the atomic plane of carbon according to the
3 reconstruction $c(2 \times 2)$, a deposit of hydrocarboned
4 molecules is made on the layer of Si followed by a
5 cracking of these molecules.

1 14. Process according to claim 13, in which the
2 hydrocarboned molecules are chosen from the group
3 comprising the molecules of C_2H_4 and the molecules of C_2H_2 .


REMARKS

The foregoing amendments correct typographical errors and multiple claim dependency for purposes of calculating the claim fee.

Attached hereto is a marked-up version of the changes made to the claims by this Amendment.

If there are any further fees required by this amendment not covered by an enclosed check, or if no check is enclosed, please charge the same to Deposit Account No. 16-0820, Order No. 33585.

Respectfully submitted,

By: 
Joseph J. Corso, Reg. No. 25845

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May 18, 2001

Version with Markings to Show Changes Made

U.S. National Application of PCT/FR99/02979
Applicant: Vincent Derycke et al.

IN THE CLAIMS:

The claims have been amended as follows:

1 1. (Amended) Monoatomic and monocrystalline layer
2 of diamond type carbon, this layer being [characterised]
3 characterized in that it is formed on the surface of a
4 monocrystalline substrate of SiC and extends closely over
5 the totality of this substrate [(2)].

1 2. (Amended) Monoatomic and monocrystalline layer
2 according to claim 1, the SiC monocrystalline substrate
3 being a thin layer [(2)] of monocrystalline SiC in cubic
4 phase β -SiC [(100)] formed on a platelet of Si, the
5 monoatomic and monocrystalline layer thus closely
6 covering the totality of this platelet.

1 4. (Amended) Monoatomic and monocrystalline layer
2 according to [any one of claims 1 to 3] claim 1, covered
3 with a monocrystalline [later] layer of diamond formed by
4 growth from the monoatomic and monocrystalline layer, the
5 latter acting as matrix.

1 5. (Amended) Manufacturing process of a monoatomic
2 and monocrystalline layer of diamond type carbon, this

process being [characterised] characterized in that one forms a monocrystalline substrate in SiC terminated by a carbon atomic plane according to a c(2x2) reconstruction, this plane being a plane of carbon-carbon dimers [(4)] of sp configuration , and in that one carries out at least one annealing of this substrate, this annealing being able to transform the plane of carbon-carbon dimers [(4)] of sp configuration into a plane of carbon-carbon dimers [(8)] of sp³ configuration thus forming a monoatomic and monocrystalline layer of diamond type carbon.

6. (Amended) Process according to claim 5, in which the SiC monocrystalline substrate is prepared from a thin layer of monocrystalline SiC in cubic phase β -SiC with a face [(100)] terminated by a layer of Si.

7. (Amended) Process according to claim 5, in which the SiC monocrystalline substrate is prepared from a monocrystalline SiC platelet in hexagonal phase with a face [(1000)] terminated by a layer of Si.

8. (Amended) Process according to [any one of claims 6 and 7] claim 6, in which, to obtain the atomic plane of carbon according to the reconstruction c(2x2), an annealing is carried out capable of eliminating the layer of Si.

1 9. (Amended) Process according to [one or the other
2 of claims 6 and 7] claim 6, in which, to obtain the
3 atomic plane of carbon according to the reconstruction
4 c(2x2), a deposit of hydrocarboned molecules is made on
5 the Si layer followed by cracking of these molecules.

1 11. (Amended) Process according to [any one of
2 claims 5 to 10] claim 5, in which, to transform the plane
3 of carbon-carbon dimers of sp configuration into a plane
4 of carbon-carbon dimers of sp³ configuration, one carries
5 out an annealing or a plurality of successive annealings,
6 at a temperature approximately equal to 1250 C, of the
7 monocrystalline substrate in SiC terminated by the atomic
8 plane of carbon according to the reconstruction c(2x2),
9 the total time of annealing being greater than or about
10 equal to 25 minutes.

Claims 12 - 14 have been added.

MONOATOMIC AND MONCRYSTALLINE LAYER OF LARGE SIZE,
IN DIAMOND TYPE CARBON, AND METHOD
FOR THE MANUFACTURE OF THIS LAYER

TECHNICAL FIELD

The present invention relates to a monoatomic and monocrystalline layer of diamond type carbon, as well as a method for manufacturing said layer.

5 STATE OF THE PRIOR ART

Diamond exists in the natural state but is very rare and expensive. Furthermore, the natural diamonds available have relatively low dimensions, which limits their use in industry, their main outlet remaining
10 jewellery.

This has led to research on methods for artificial production of diamond.

In fact, diamond is far and away the best semiconductor possible for the electronics industry. It
15 outclasses silicon and the semiconductor compounds III-V by at least four times in terms of quality factor (in particular as far as rapid electronics, high powers and high temperatures are concerned).

It is also a biocompatible material and is very
20 hard.

However, in order to use it, it is imperative to have available monocrystals of diamond of sufficient size, especially in the field of microelectronics.

The synthesis procedures developed so far require
25 the intervention of extreme growth conditions: high

pressures, high temperatures, plasmas, chemical deposits in vapour phase and TNT explosion techniques.

The result has been the production of crystals with low dimensions (the smallest do not exceed 4 nm) and whose assembly has not allowed crystals of greater dimensions to be obtained.

DESCRIPTION OF THE INVENTION

The aim of the present invention is to rectify the above inconveniences and, in order to do this, to suggest a structure having electronic, chemical and structural properties close to those of diamond, which will make it possible to obtain a base on which the growth of layers of diamond can take place under the same conditions: the same chemical element (carbon), the same electronic properties (sp^3 configuration), and the lowest possible lattice discrepancy between the substrate and the crystal of diamond.

To be precise, the present invention has the aim of a monoatomic and monocrystalline layer of carbon of the diamond type, this layer being characterised in that it is formed on the surface of a monocrystalline substrate in SiC and extends closely over the totality of this substrate.

According to a first special embodiment of the monoatomic layer and monocrystalline layer, the aim of the invention, the monocrystalline substrate in SiC is a thin layer of monocrystalline SiC is a thin monocrystalline layer of SiC in cubic phase β -SiC (100), the monoatomic and monocrystalline layer thus closely covering the totality of this platelet.

According to a second special embodiment, the monocrystalline substrate in SiC is a monocrystalline platelet of SiC in hexagonal phase, the monoatomic and monocrystalline layer thus closely covering the
5 totality of this platelet.

Starting from the monoatomic and monocrystalline layer, the aim of the invention, one can obtain a monocrystalline layer of diamond which covers the monoatomic and monocrystalline layer and which is
10 formed by growth from this monoatomic and monocrystalline layer, the latter acting as matrix.

The present invention also has the aim of a method of manufacture of a monoatomic and monocrystalline layer of diamond type carbon, this method being
15 characterised in that one forms a monocrystalline substrate in SiC terminated by an atomic plane of carbon according to a reconstruction $c(2 \times 2)$, this plane being a plane of carbon-carbon dimers of sp configuration, and in that one carries out at least one
20 annealing of this substrate, this annealing being capable of transforming the plane of carbon-carbon dimers of sp configuration into a plane of carbon-carbon dimers of sp^3 configuration thus forming a monoatomic and monocrystalline layer of diamond type
25 carbon.

According to a first particular embodiment of operation of the method according to the invention, the monocrystalline substrate in SiC is prepared from a thin layer of monocrystalline SiC in cubic phase β -SiC
30 with one face (100) terminated by a layer of Si.

According to a second particular embodiment, the monocrystalline substrate in SiC is prepared from a thin layer of a platelet of monocrystalline SiC in hexagonal phase having one face (1000) terminated by a layer of Si.

In order to obtain the atomic plane of carbon according to the reconstruction $c(2 \times 2)$, one can carry out an annealing capable of eliminating the Si layer or make a deposit of hydrocarboned molecules on the Si layer followed by a cracking of these molecules.

The hydrocarboned molecules can be chosen from the group comprising molecules of C_2H_4 and molecules of C_2H_2 .

According to a special embodiment of the invention, in order to transform the plane of carbon-carbon dimers of sp configuration into a plane of carbon-carbon dimers of sp^3 configuration, one carries out an annealing or a plurality of successive annealings, at a temperature of about $1250^\circ C$, of the monocrystalline substrate in SiC terminated by the atomic plane of carbon according to the reconstruction $c(2 \times 2)$, the total length of time of annealing being greater than or about equal to 25 minutes.

The present invention makes it possible to use a substrate with properties very close to those of diamond: the same chemical element (carbon), the same type of bond (sp^3), the same electronic properties and even the same structure, with the only difference that the parameter of the substrate lattice is greater than that of diamond.

Nonetheless, this substrate presents the smallest lattice discrepancy possible with diamond when one compares other substrates such as silicon or certain insulators.

5 At the atomic level, control of the nucleation phase on a carbon terminated SiC surface according to the invention makes it possible to have a desired structural pattern identical to that of diamond.

10 Thus, on the atomic scale, one has a matrix making it possible to grow a thicker, monocrystalline layer of diamond.

 This matrix is capable of having a large surface area in comparison with that of the platelets of silicon or silicon carbide.

15 It should be noted that the invention was made possible by the perfect mastery, at the atomic level, of the different compositions and reconstructions of the surfaces of β -SiC (100), in particular the surfaces of β -SiC (100) 3×2 , β -SiC (100) $c(4 \times 2)$ and β -SiC (100) $c(2 \times 2)$.

20 Considering this subject, documents [1] to [10] can be consulted which, just like the other documents quoted below, are mentioned at the end of the present description.

25 Tunnel effect microscopy has confirmed the idea that the surfaces obtained were, contrary to all expectations and taking into account the state of the art, (a) of very high quality (comparable to that obtained on silicon surfaces), with a low fault
30 density, (b) plates and (c) without corrugations.

BRIEF DESCRIPTION OF THE DRAWING

The present invention will be better understood by reading the description of examples of embodiments given below, as purely indicative and in no way
 5 limiting, referring to the unique figure attached which is a diagrammatic view from above of a monoatomic and monocrystalline layer of diamond type carbon according to the invention, during formation.

10 DETAILED DESCRIPTION OF SPECIAL EMBODIMENTS

The production of a monoatomic and monocrystalline layer of diamond type carbon according to the invention is, for example, carried out in a sealed chamber (not shown), maintained at a pressure lower than 5×10^{-9} Pa or
 15 under neutral atmosphere.

For example, one uses a substrate of silicon carbide constituted of a very thin monocrystalline film, of a thickness of the order of $1 \mu\text{m}$, of silicon carbide in cubic phase $\beta\text{-SiC}$ (100).

20 This substrate can be obtained by chemical deposit in vapour phase of a first gaseous component containing carbon and a second gaseous component containing silicon on a neighbouring surface of Si (100) oriented at 4° .

25 As an example, the first gaseous compound is C_3H_8 and the second gaseous compound is SiH_4 .

One can also use, as a substrate, a solid monocrystal of SiC.

30 Consult documents [5], [6] and [7] on this subject.

From this substrate whose surface is Si terminated (that is terminated by an atomic layer of silicon), one next prepares a surface of cubic silicon carbide (β -SiC (100)) terminated by an atomic plane of carbon according to a c(2x2) reconstruction.

Consult documents [11], [12], [13] and [14] on this subject.

In order to prepare this surface, one eliminates selectively the plane of silicon by thermal annealing at a temperature of about 1200°C for about 10 minutes.

Instead of this one can make a deposit of hydrocarboned molecules on the layer of silicon, for example a deposit of C_2H_4 or C_2H_2 molecules, and then carry out a cracking of these molecules at 950°C.

Consult documents [1] to [4], and [11] to [14] on this subject.

One thus obtains the C terminated surface, that is to say terminated by an atomic plane of carbon, and reconstructed c(2x2).

The atomic plane of carbon is a plane of carbon-carbon dimers of sp configuration: in each dimer the two atoms of carbon are linked by a triple bond $C\equiv C$.

Then, to obtain the monoatomic layer of carbon of diamond type, one transforms the plane of dimers of sp configuration into a plane of carbon-carbon dimers of sp^3 configuration.

In order to do this, one carries out an annealing or a plurality of successive annealings of the surface, the temperature of annealing and the total length of time of annealing being chosen to cover the surface of these dimers of sp^3 configuration.

As an example, one carries out a single annealing at about 1250°C for at least 25 minutes, or several successive annealings at about 1250°C for respective lengths of time which together total at least 25 minutes (for example, two annealings at 1250°C, the first for 15 minutes and the second for 23 minutes).

Instead of this one can heat the substrate for at least 25 minutes but at a temperature higher than 1250°C.

10 The single attached figure is a diagrammatic view from above of the layer of carbon of diamond type in compliance with the invention during formation on a substrate 2 in SiC.

One sees the $C\equiv C$ dimers of sp type which are referenced 4 and, below these, the silicon atoms which are referenced 6.

During annealing or successive annealings there is a rupture of the triple bonds and a rearrangement of the carbon atoms to form single bonds under the form of C-C dimers of sp^3 type, referenced 8, these single bonds being perpendicular to the preceding triple bonds, referenced 10 corresponding to the hanging bond of each C-C dimer.

Thus one obtains carbon atom chains such as chain 12 and, with sufficient annealing time or with a sequence of annealings with a sufficient total time, the number of chains of carbon atoms increases to reach a state where these carbon atoms cover the whole of the surface of the substrate 2 to form a monoatomic and monocrystalline layer of carbon of diamond type.

Thus one has a relatively simple process (thermal annealing or sequence of thermal annealings) on a commercially available material, that is cubic silicon carbide.

5 This material is available commercially under the form of thin layers on silicon platelets 10 cm in diameter.

10 The invention therefore makes it possible to grow diamond crystals with dimensions comparable to those of other semiconductors.

 In the example under consideration, a face (100) of a SiC substrate was used but instead of this one could use a face (111).

15 Furthermore, in this example, a substrate of cubic silicon carbide was used, but the invention can also be applied to a substrate of hexagonal silicon carbide with an Si terminated face (1000).

 This face has the same structure as cubic β -SiC (111).

20 Consult document [1] on this subject.

 It should be noted that monocrystal platelets of hexagonal silicon carbide (phases 4H and 6H) of 0.5 mm thickness are commercially available, with diameters reaching three inches (about 7.5 cm).

25 When a monoatomic and monocrystalline layer of carbon of diamond type has been produced in accordance with the invention, it is possible to grow, on this layer, a diamond monocrystalline layer by a method known to those skilled in the art. Consult, for
30 example, document [15] on this subject.

INDUSTRIAL APPLICATIONS

The fields of application of the present invention are extremely wide: microelectronics, optoelectronics, micromechanics and biomaterials (prostheses).

5 In electronics, diamond is potentially the best semiconductor possible, with exceptional properties. It is able to lead to the production of devices with performances never yet attained.

10 In optoelectronics, diamond is a material whose surface can operate in a negative electro-affinity regime, which is of great interest for ultra-sensitive photo-cathodes (in particular for night vision and video cameras). Furthermore, these negative electro-affinity properties can lead to the production of
15 cathodes with microtips for emission by field effect, cathodes with which one can produce flat video screens.

Diamond is also an excellent material for use in the production of X-ray detectors.

20 Furthermore, in micromechanics, diamond can provide very hard coatings.

And yet again, in the field of biomaterials, diamond is the best, or at least one of the best, biocompatible materials and can be used as a basis for manufacturing prostheses or implants.

25 The development of microelectronics techniques with diamond requires the availability of large sized substrates in diamond, which the present invention provides.

30 The documents quoted in the description are the following:

[1] P. Soukiassian, F. Semond, L. Douillard, A. Mayne, G. Dujardin, I. Pizzagalli and C. Joachim, Phys. Rev. Lett. 78, 907 (1997).

5 [2] V. Yu Aristov, L. Douillard, O. Fauchoux and P. Soukiassian, Phys. Rev. Lett. 79, 3700 (1997).

[3] P. Soukiassian, F. Semond, A. Mayne and G. Dujardin, Phys. Rev. Lett. 79, 2498 (1997).

10 [4] G. Dujardin, A. Mayne, F. Semond and P. Soukiassian, French patent application N° 9615435 of December 16, 1996 in the name of C.E.A. and C.N.R.S. (FR2757183A) - see also W098/27578 published June 25,
15 1998.

[5] M. Riehl-Chudoba, P. Soukiassian and C. Jaussaud, J. Appl. Phys. 76, 1332 (1994).

20 [6] M. Riehl-Chudoba, S. Dupont and P. Soukiassian, Surf. Sci. 331-333, 625 (1995).

[7] M. Riehl-Chudoba, P. Soukiassian, C. Jaussaud and S. Dupont, Phys. Rev. B 51, 14300 (1995).

25 [8] F. Semond, P. Soukiassian, P.S. Mangat and L. di Cioccio, J. Vac. Sci. Tech. B 13, 1591 (1995).

[9] F. Semond, L. Douillard, P. Soukiassian, D. Dunham, F. Amy and S. Rivillon, Appl. Phys. Lett. 68,
30 2144 (1996).

[10] F. Semond, P. Soukiassian, P.S. Mangat, Z. Hurych, L. di Cioccio and C. Jaussaud, Appl. Surf. Sci. 104-105, 79(1996).

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CLAIMS

1. Monoatomic and monocrystalline layer of diamond type carbon, this layer being characterised in that it is formed on the surface of a monocrystalline substrate of SiC and extends closely over the totality of this substrate (2).

2. Monoatomic and monocrystalline layer according to claim 1, the SiC monocrystalline substrate being a thin layer (2) of monocrystalline SiC in cubic phase β -SiC (100) formed on a platelet of Si, the monoatomic and monocrystalline layer thus closely covering the totality of this platelet.

3. Monoatomic and monocrystalline layer according to claim 1, the monocrystalline substrate in SiC being a platelet of monocrystalline SiC in hexagonal phase, the monoatomic and monocrystalline layer thus closely covering the totality of this platelet.

4. Monoatomic and monocrystalline layer according to any one of claims 1 to 3, covered with a monocrystalline layer of diamond formed by growth from the monoatomic and monocrystalline layer, the latter acting as matrix.

5. Manufacturing process of a monoatomic and monocrystalline layer of diamond type carbon, this process being characterised in that one forms a monocrystalline substrate in SiC terminated by a carbon

atomic plane according to a c(2x2) reconstruction, this plane being a plane of carbon-carbon dimers (4) of sp configuration , and in that one carries out at least one annealing of this substrate, this annealing being
5 able to transform the plane of carbon-carbon dimers (4) of sp configuration into a plane of carbon-carbon dimers (8) of sp^3 configuration thus forming a monoatomic and monocrystalline layer of diamond type carbon.

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6. Process according to claim 5, in which the SiC monocrystalline substrate is prepared from a thin layer of monocrystalline SiC in cubic phase β -SiC with a face (100) terminated by a layer of Si.

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7. Process according to claim 5, in which the SiC monocrystalline substrate is prepared from a monocrystalline SiC platelet in hexagonal phase with a face (1000) terminated by a layer of Si.

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8. Process according to any one of claims 6 and 7, in which, to obtain the atomic plane of carbon according to the reconstruction c(2x2), an annealing is carried out capable of eliminating the layer of Si.

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9. Process according to one or the other of claims 6 and 7 in which, to obtain the atomic plane of carbon according to the reconstruction c(2x2), a deposit of hydrocarboned molecules is made on the Si layer
30 followed by cracking of these molecules.

10. Process according to claim 9, in which the hydrocarboned molecules are chosen from among the group comprising the molecules of C_2H_4 and the molecules of C_2H_2 .

5

11. Process according to any one of claims 5 to 10, in which, to transform the plane of carbon-carbon dimers of sp configuration into a plane of carbon-carbon dimers of sp^3 configuration, one carries out an annealing or a plurality of successive annealings, at a temperature approximately equal to $1250^\circ C$, of the monocrystalline substrate in SiC terminated by the atomic plane of carbon according to the reconstruction $c(2 \times 2)$, the total time of annealing being greater than or about equal to 25 minutes.

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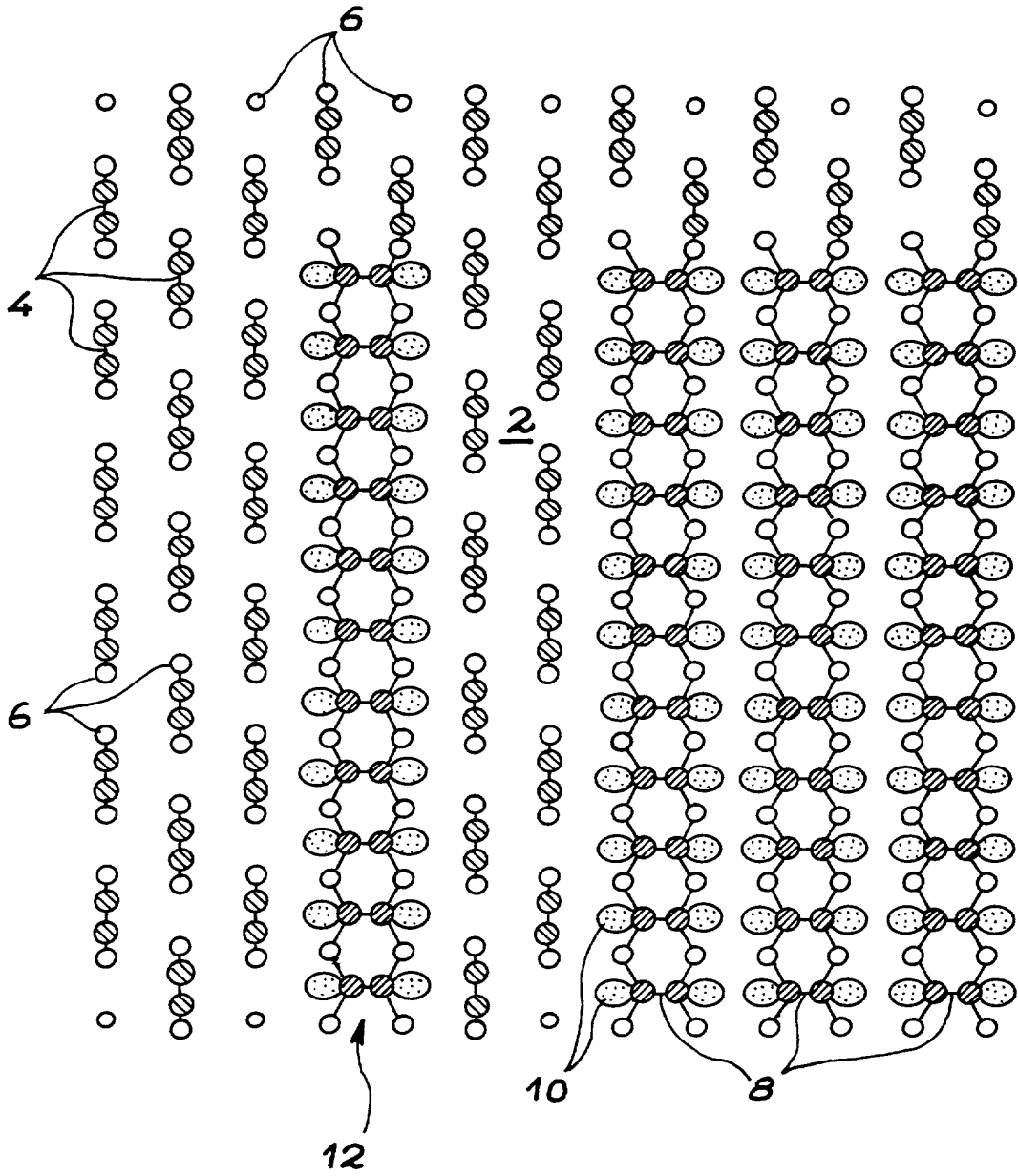
ABSTRACT OF THE DISCLOSUREMONOATOMIC AND MONOCRYSTALLINE LAYER OF LARGE SIZE,
IN DIAMOND TYPE CARBON, AND METHOD
FOR THE MANUFACTURE OF THIS LAYER

Monoatomic and monocrystalline layer of large size, in diamond type carbon, and method for the manufacture of this layer.

According to the invention, a monocrystalline substrate (2) is formed in SiC terminated by an atomic plane of carbon according to a reconstruction $c(2 \times 2)$ and at least one annealing is carried out, capable of
5 transforming this atomic plane, which is a plane of dimers $C \equiv C$ (4) of sp configuration, into a plane of dimers $C-C$ (8) of sp^3 configuration. Application to microelectronics, optics, optoelectronics, micromechanics and biomaterials.

10

Unique figure.



Declaration, Power Of Attorney and Petition

Page 1 of 3

WE (I) the undersigned inventor(s), hereby declare(s) that :

My residence, post office address and citizenship are as stated below next to my name,

We (I) believe that we are (I am) the original, first, and joint (sole) inventor(s) of the subject matter which is claimed and for which a patent is sought on the invention entitled

MONOATOMIC AND MONOCRYSTALLINE LAYER OF LARGE SIZE, IN DIAMOND

TYPE CARBON, AND METHOD FOR THE MANUFACTURE OF THIS LAYER

the specification of which

☐ is attached hereto.

☐ was filed on

as Application Serial No.

and amended on

☒ was filed as PCT international application

Number PCT/FR99/02979

on December 01, 1999

and was amended under PCT Article 19

on

We (I) hereby state that we (I) have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

We (I) acknowledge the duty to disclose information known to be material to the patentability of this application as defined in Section 1.56 of Title 37 Code of Federal Regulations.

We (I) hereby claim foreign priority benefits under 35 U.S.C. § 119 (a)-(d) or § 365 (b) of any foreign application(s) for patent or inventor's certificate, or § 365 (a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application (s)

Application No.	Country	Day/month/Year	Priority Claimed
98 15218	FRANCE	02 DECEMBER 1998	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
_____	_____	_____	<input type="checkbox"/> YES <input type="checkbox"/> NO
_____	_____	_____	<input type="checkbox"/> YES <input type="checkbox"/> NO
_____	_____	_____	<input type="checkbox"/> YES <input type="checkbox"/> NO

We (I) hereby claim the benefit under Title 35, United States Code, § 119 (e) of any United States provisional application(s) listed below.

(Application Number)

(Filing Date)

(Application Number)

(Filing Date)

We (I) hereby claim the benefit under 35 U.S.C. §120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of prior application and the national or PCT International filing date of this application.

Application Serial No.

Filing Date

Status (pending, patented,
abandoned)

17 And we (I) hereby appoint :Charles B. Gordon, Registration Number 16,923; William C. McCoy, Registration Number 16,885; Louis V. Granger, Registration Number 15,999; William A. Gail, Registration Number 17,409; Richard H. Dickinson Jr, Registration Number 18,622; Thomas P. Schiller, Registration Number 20,677; David B. Deioma, Registration Number 22,841; Joseph J. Corso, Registration Number 25,845; Howard G. Shimola, Registration Number 26,232; Jeffrey J. Sopko, Registration Number 27,676; John P. Murtaugh, Registration Number 34,226; James M. Moore, Registration Number 32,923; David E. Spaw, Registration Number 34,732; Michael W. Garvey, Registration Number 35,878; Paul R. Katterle, Registration Number 36,563; Richard M. Mescher, Registration Number 38,242 and Mark E. Bandy, Registration Number 35,788; our (my) attorneys, with full powers of substitution and revocation, to prosecute this application and to transact all business in the Patent Office connected therewith; and we (I) hereby request that all correspondence regarding this application be sent to the firm of PEARNE, GORDON, McCOY & GRANGER whose Post Office Address is : 1200 Leader Building Cleveland, Ohio 44114.

We (I) declare that all statements made herein of our (my) own knowledge are true and that all statements made on information and belief are believed to be true ; and future that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardise the validity of the application or any patent issuing thereon.

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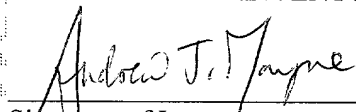
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